RESULTS OF INDOOR AIR QUALITY INVESTIGATION

NAVAL SEA SYSTEM COMMAND

BUILDING 176 ("EMERGENCY")

WASHINGTON NAVY YARD

CONDUCTED FOR:

NAVSEA

OCTOBER 2001

ADVANCED ENVIRONMENTAL SERVICES, INC.

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EXECUTIVE SUMMARY

Following a breach in containment, AESI returned to Building 176 on October 25 on an emergency basis. The purpose was to conduct a visual inspection and testing for possible expanded mold issues previously identified. A total of seven (7) samples were taken – four (4) air samples and three (3) swab samples. Once samples were collected, they were sealed and sent to the same outside independent lab previously used.

On the Outside South Side the air sample results were 40 Counts per Cubic Meter of Air.

Inside, three (3) air samples were taken. Both the South End Encapsulated Area and the Office in Area OMB Bar were reported to contain 40 Counts each.

The lowest air sample taken was from the North End Encapsulated Area with less than 13 Counts.

In addition three (3) bulk samples were taken. The first sample Outside Containment contained 1 – 5 % *Amerospores*. The second sample Outside Containment had 1 – 5 % *Ascospores*. The Inside Office Center contained no fungal spores.

On this date *Stachybotrys* was <u>not</u> found outside the containment area.

As before, it appears that the mold levels are not within the guidelines currently used and *Stachybotrys* has been shown to exist. Remediation is warranted. Following remediation, clearance sampling should be conducted by or under the direction of a Certified Industrial Hygienist prior to reconstruction to verify successful abatement.

The report is based on information available to us at this time. No other aspects if indoor air quality (IAQ) were examined. AESI reserves the right to revise, supplement, and otherwise amend our opinions and conclusions, if necessary and warranted by the discovery of new or additional information.

David O. Anderson, Ph.D.
CIH, CSP, QEP, CPEA

January 25, 2001
Date Issued

INTRODUCTION, METHODOLOGIES, AND OBSERVATIONS

NavSea contacted Dr. David Anderson of Advanced Environmental Services, Inc. regarding a possible indoor air quality issue in Building 176 following discovery of *Stachybotrys* by AESI in September 2001.

A plastic containment wall had been erected floor to ceiling along the West side of this building. The containment included several cubicles and an Office. The containment had been cut to allow a worker access to the firewater pump and piping, and to an Office. The rest of the ground floor was still in use by NavSea personnel

The purpose of the visit was to conduct a visual inspection of the containment, and to collect airborne and bulk samples to determine if a possible health risk was present due to the release of *Stachybotrys.*

The investigation was conducted in accordance with the recommendations and guidelines of the American Conference of Governmental Industrial Hygienists (ACGIH), the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE), the Occupational Safety and Health Administration (OSHA), the National Institute for Occupational Safety and Health (NIOSH), the Environmental Protection Agency (EPA), and established industry standards.

On October 25, 2001, AESI returned to Building 176 and inspected the primary areas of concern. Evidence of the cut plastic was apparent, and other than containment, nothing had apparently been done to remediate the mold. (Please refer to previous AESI reports).

Four (4) Zefon^{TM} Air-O-Cell cassettes for total, non-viable airborne organisms were taken – three inside the containment and the other outside for comparison. (For specific locations, please refer to Appendix A). Air-O-Cell cassettes collect samples for total organisms – both living (viable) and non-living (non-viable). The sampling pumps had been calibrated prior to arrival using a rotameter. These samples provide information on total fungal colony Counts per Cubic Meter (Counts / M^3).

In addition, three (3) bulk (swab) samples were also collected. The "swab" method uses a Sterile BBL Culture Swab collected over an approximately one hundred square centimeter surface area; the swab is placed into a plastic holder containing agar, sealed and labeled. All samples were sealed and shipped via Fed-Ex to an outside, independent microbiological lab that specialized in identification and analyses of these types of samples; in addition, they also participate in an Environmental Microbiological Proficiency Analytical Testing (EMPAT) quality control program administered by the American Industrial Hygiene Association, designed for maximum quality and control. This was the same lab previously used. Chain-of-Custody forms were maintained.

Expedited lab results were requested. The preliminary results for the samples were received via fax, followed by mail. (Appendix B, sample numbers 1-7). A fax was sent to the COTR, Michael Smith, on October 29, 2001, with the preliminary data.

RESULTS AND DISCUSSION

TOXICOLOGICAL AND HEALTH EFFECTS

BIOAEROSOLS:

Bioaerosols include any biological agent, which becomes airborne. Bioaerosols may include pollens, animal dander, bacteria, as well as fungi. Because fungi are spore-bearing organisms, which are ideally suited for airborne transport, they often produce symptoms of discomfort among certain individuals.

Fungi originally were considered as a group of plants lacking any stems leaves or roots. Consequently, they were classified along with algae and the lichens. Fungi differed from those groups, however, in their lack of chlorophyll. Fungi exist as parasites (plant, animal and human pathogens) or as saprophytes (decomposers of non-living organic matter).

There are currently about 80,000 described species of fungi, both yeasts and molds, with probably more species awaiting discovery. Fungi are beneficial as food, as producers of antibiotics, as fermenting agents, as sources of drugs, as well as in many aspects of industry. Fungi are also well documented for their role in allergy.

Those fungi most responsible for causing allergy include species belonging to *Alternaria, Cladosporium, Aspergillus, Drechslera, Fusarium, Phoma, Epicoccum, Penicillium, Rhizopus, Mucor, Aureobasidiurn pullulans, Nigrospora, Scopulariopsis* and spores of rusts and smuts. *Cladosporium* is the most common fungus found in the air, followed by *Alternaria, Penicillium, Aspergillus, Fusarium, and Aureobasidium pullulans.* Clinically, the causative allergenic agents for most persons sensitive to fungi are *Cladosporium* and *Alternaria.*

Aspergillus, Penicillium, Rhizopus, Mucor, Fusarium and *Cladosporium* are examples of fungi that can produce a large number of spores. As they are present at all times in both the indoor and outdoor environments and are an important factor in the production of allergy in susceptible individuals.

Although fungi may grow and produce spores in the water and soil, dead organic debris is considered the main repository for aerobic fungi. Fungal spores will disperse from leaf litter, decaying plant material and other available organic substrata into the air and then fall onto vegetation where they may cause disease; are carried into homes and offices where they may cause moldy bathrooms and basements; and inhaled by humans and animals where they may cause toxic reactions, disease, an allergy, or other fungal disorders; fall onto leather, wood, or food, causing various mold damage; or fall back to or sail onto other supportive materials and repeat the cycle. In any case, fungi cannot produce their own food and therefore must find a source of organic matter in order to survive. High humidity is also necessary for fungal growth and spore germination.

It is important to note that airborne fungal spores must be viable to produce disease or to grow and germinate, but they <u>do not</u> have to be viable to produce allergenic effects in sensitive people. Although a bright sunny afternoon might substantially reduce the viability of fungal spores in the air, it will not bring relief to persons suffering from fungal allergy. There is some indication that the occupants of this residence may currently suffer from this allergic reaction.

Fungal spores are always present in the air, with rain and snow washing down most from the air, and the wind and sunshine causing an increase in the atmospheric distribution of spores. The number of airborne fungi is lowest during the winter months and highest during the summer and autumn months, when dead organic debris is more plentiful.

From the compilation of numerous data, the following distribution indicates the majority and frequency of fungal organisms typically isolated in indoor environments:

Organism	Per Cent
Cladosporium	100
Penicillium	91
Alternaria	87
Epicoccum	53
Aspergillus sp.	49
Aureobasidium	44
Drechslera	38
Acremonium	36
Fusarium	25
Aspergillus niger	19
Rhizopus	13

Possible health effects associated with fungi generally fall into one of three groups:

1. Allergic: sensitization and immune responses such as allergic rhinitis (hay fever), asthma, or hypersensitivity pneumonitis.
2. Infectious: growth of the fungus in or on the body, as with aspergillosis or histoplasmosis
3. Toxic: disruption of cellular function and interaction with DNA, as occurs with toxigenic effects, including aflatoxin-induced cancer.

Mycotoxins exert their effect on organisms in many ways including interference with cellular respiration, interference with carbohydrate and lipid metabolism, and direct binding with DNA and RNA. Several trichothecene mycotoxins are produced by *Stachybotrys*, and both *Aspergillus* and *Penicillium* can produce ocharatoxin A. (For detailed explanations, please refer to Appendix C).

STACHYBOTRYS HEALTH EFFECTS

Stachybotrys atra (SA) can produce several toxic chemicals called trichothecene mycotoxins. These mycotoxins are known to be toxic to both humans and farm animals exposed to significant quantities. Initially the toxic effects of the mold were seen in farm animals that had eaten contaminated hay or grain. Farm workers also experienced health effects (dermatitis, blood and immune system disorders) from handling contaminated material. A recent evaluation of several tricothecenes by the International Agency for Research on Cancer (IARC) found no evidence that they cause cancer.

There have been only a few documented cases of health problems from indoor exposure to SA. In general, the intensity of exposure and health effects from SA in the indoor environment is much less severe than those, which were experienced by farm animals and workers.

If SA spores are released into the air, there is a potential for allergic, respiratory or immunologic symptoms to develop or become exacerbated. These conditions include: asthma, hypersensitivity pneumonitis, allergic rhinitis, dermatitis, sinusitis and conjunctivitis. It is thought that these diseases are mediated by an immune response to SA (or other environmental agents). Many of the related symptoms are non-specific, but debilitating, such as discomfort, inability to concentrate and fatigue. Presently, it is not known whether long-term indoor exposure to airborne SA increases the risk of certain chronic respiratory diseases. In one reported case of indoor exposure, residents experienced cold and flu symptoms, diarrhea, headaches, fatigue, rashes and other symptoms. These symptoms disappeared after all of the contaminated ductwork, insulation, and ceiling material was replaced.

ASSOCIATION BETWEEN SA IN BUILDINGS AND HEALTH EFFECTS

Health risk cannot be predicted based simply on the presence of SA in building materials as indicated by sampling results. In order for humans to be exposed indoors, spores must be released into the air and inhaled. Also, it appears that the symptoms listed above are not likely to develop in all persons exposed at levels likely to be found in buildings. The attack rate

(percentage of persons who develop symptoms) is generally low. At the present time, "safe" (or "unsafe") exposure levels have not been established.

INTERPRETATIVE GUIDELINES

Previous research and test data have revealed that indoor airborne spore levels of 30 % to 70 % of the outdoor spore levels are normal, with the same general distribution of spore types. Filtered air, air-conditioned air, or air remote from outside sources may average 5 to 15 % of the outside air at the time of sampling. Based on these guidelines, a residence with open doors and windows and heavy foot traffic may average 135 % of the outdoor level while a high rise office building with little air exchange may average 2 %. In addition, dusty interiors may exceed 100 % of the outdoors to some degree, but will still mirror the outdoor distribution of spore types. Dusty conditions were not noted.

Data collected by the National Institute for Occupational Safety and Health (NIOSH) collectively suggest that a level of 1,000 total colony-forming units (cfu) per cubic meter of air (M^3) may warrant investigation and remedial action. The American Conference of Governmental Industrial Hygienists (ACGIH) Committee on Bioaerosols suggests that the indoor air-borne fungal spore concentration, either in Colony Forming Units or as Countable organisms, should not exceed 30 % of the outside levels and that the indoor level should be qualitatively similar to the outside level; currently there is no TLV for mold. During the growing season, according to the OSHA Technical Manual, levels of outdoor airborne fungal spore levels can range from 1,000 to 100,000 cfu/M^3. This reference goes on to indicate that airborne contaminant indicators are 1,000 cfu/M^3, but that levels above this do not necessarily imply that the conditions are unsafe or hazardous. Risk management investigation should be initiated if the following species are confirmed to be present: *Stachybotrys, Aspergillus versicolor*, *Aspergillus flavus, Aspergillus fumigatus*, and / or *Fusarium moniforme.*

In April 2000, the Indoor Air Quality Association published "Recommended Guidelines for Indoor Environments" (IAQA 01-2000). In this document, their recommendation for culturable (viable) fungal bioaerosols was 300 cfu/M^3 for total and 50 cfu/M^3 for individual fungal spores, excluding *Cladosporium*.

Currently in the United States, IAQ issues are not regulated by a governmental agency. The ACGIH recommends gathering the best data possible and using knowledge, experience, expert opinion, logic, and common sense interpretation of current information. As stated earlier, microbiological species present in the indoor environment should be generally representative of the species in the outdoor environment to a significantly lesser degree. The indoor air samples should not contain specific identifiable pathogenic microbiological organisms.

AIR-O-CELL RESULTS:

The Air-O-Cell Cassette is a unique sampling device designed for the rapid collection and analysis of a wide range of airborne particles, including fungal spores. Air is drawn through a sampling cassette that contains a small, greased microscopic slide; the samples are analyzed via light microscopy at 600X magnification, with the entire slide (100% of the sample) being analyzed. The results are reported as **total**, meaning they include both viable (i.e., living) and non-viable fungal spores. This technique does not allow for the differentiation between *Aspergillus* and *Penicillium* spores, due to the small size. Small spherical fungal spores that cannot be identified and may include *Aspergillus*, *Penicillium*, and *Trichoderma* are grouped together as *Amerospores.* Additionally it does not allow for cultivation or speciation of spores. Typically the results from this collection and analysis method are higher than the Petri dish method, as <u>all</u> spores are collected and counted.

The sample results produced by the lab were received initially by fax and final copies via mail (Appendix B).

On the Outside (South Side) the air results were 40 Counts per Cubic Meter of Air – all *Amerospores*.

Inside, three (3) air samples were taken. Both the South End of the Encapsulated Area and the Office in Area OMB Bar were reported to contain 40 Counts each.

The South End of the Encapsulated Area was reported to contain 40 Counts - 100 % *Amerospores*.

The Office in Area OMB Bar was reported to contain 40 Counts - 67 % *Amerospores* and 33 % *Curvularia*.

The lowest air sample taken was from the North End of the Encapsulated Area with less than 13 Counts.

BULK SAMPLES:
In addition three (3) swab samples were taken. The first sample Outside Containment on the North side contained 1 – 5 % *Amerospores*. The second sample Outside Containment on the South side had 1 – 5 % *Ascospores*. The Inside Office Center sample was reported not to contain any fungal spores.

CONCLUSIONS

The primary source of moisture appears to be from the plumbing leak in and around the firewater system, which was identified during the AESI baseline conducted in September 2001. No work has been conducted on mold abatement, but containment consisting of plastic sheeting floor to ceiling has been installed.

With the breach of containment, *Stachybotrys* does not appear to have been released into the Office spaces. Contamination appears to be still present, and decontamination and mold abatement is warranted.

RECOMMENDATIONS

Please review the earlier AESI reports for suggested remediation protocols.

These procedures are designed to minimize both exposure to the remediation crews and to minimize further exposure to the dwelling and contents. Temporary living quarters are suggested while this remediation activity is conducted, due to possible allergic and / or toxic consequences.

After remediation, additional visual inspection and clearance sampling conducted by or under the direction of a Certified Industrial Hygienist – not the abatement contractor – should be conducted to verify the results of the abatement prior to reconstruction and occupancy. Air scrubbers must be turned off 24 to 48 hours before clearance testing.

Appendix A

Sampling Locations

Sample Locations

Sample Number	Sample Type	Location
1	Swab	North side, outside Containment
2	Swab	South side, outside Containment
3	Swab	Center, Inside Office
4	Air-O-Cell	Inside Containment, North
5	Air-O-Cell	Inside Containment, South
6	Air-O-Cell	Outside Area OMB Bar
7	Air-O-Cell	Outside, South Side

Appendix B

Microbiological Results

And

Lab Data

AESI
1112 Charleston Ct.
Keller, TX 76248
Attn: Dr. David Anderson

Lab Number: A-110-4609
Project Name: 176 Emergency
Project Number: 1082
Date Received: 10/26/01
Date Reported: 10/26/01

AIHA Emapt No. 102297

Microscopic Screen and Fungi Identification

Aerotech Method: S001

Lab Number	**1**	**2**	**3**
Sample Identification	#1 Outside Containment (N)	#2 Outside Containment (S)	Inside Office Center
Date Analyzed	10/26/2001	10/26/2001	10/26/2001
	Results	**Results**	**Results**
Mycelial Fragments	None Detected	None Detected	None Detected
Fungal Spores	1-5%	1-5%	None Detected
	Fungal Spore Identification	**Fungal Spore Identification**	**Fungal Spore Identification**
Alternaria			
Amerospores	1-5%		
Arthrinium			
Ascospores		1-5%	
Aspergillus/Penicillium			
Aureobasidium			
Basidiospores			
Bipolaris/Dreschlera			
Botrytis			
Chaetomium			
Cladosporium			
Curvularia			
Epicoccum			
Fusarium			
Nigrospora			
Oidium/Peronospora			
Pithomyces/Ulocladium			
Rusts			
Smuts/Myxomycetes			
Stachybotrys			
Stemphylium			
Torula			
Unidentified Conidia			
Notes:			

Prepared By:
CS Review:

Technical Review:
Final Review:

AESI
1112 Charleston Ct.
Keller, TX 76248
Attn: Dr. David Anderson

AIHA Empat No. 102297

Air-O-Cell Cassette Analysis

Aerotech Method: A001

Lab Number: A-110-4609
Project Name: 176 Emergency
Project Number: 1082
Date Received: 10/26/01
Date Report Revised: 10/29/01

Lab Number	4				5				6			
Sample Identification	Outside, South Side				South End Encapsulated Area				Office In Area OMB Bar			
Volume (M^3)	0.0750				0.0750				0.0750			
Date Analyzed	10/26/2001				10/26/2001				10/26/2001			
Percent Of Trace Analyzed	100% of Trace at 600X Magnification				100% of Trace at 600X Magnification				100% of Trace at 600X Magnification			
Debris Rating	0				1				1			
		Count/M^3				Count/M^3				Count/M^3		
	Total Count	Result	Detection Limit	%	Total Count	Result	Detection Limit	%	Total Count	Result	Detection Limit	%
Mycelial Fragments	<1	<13	13	n/a	<1	<13	13	n/a	<1	<13	13	n/a
Pollen Count	<1	<13	13	n/a	<1	<13	13	n/a	<1	<13	13	n/a
Total Fungal Spores	<1	<13	13	n/a	3	40	13	100	3	40	13	100
	Fungal Spore Identification				Fungal Spore Identification				Fungal Spore Identification			
Alternaria												
Amerospores					3	40	13	100	2	27	13	67
Arthrinium												
Ascospores												
Aspergillus/Penicillium												
Aureobasidium												
Basidiospores												
Bipolaris/Dreschlera												
Botrytis												
Chaetomium												
Cladosporium									1	13	13	33
Curvularia												
Epicoccum												
Fusarium												
Nigrospora												
Oidium/Peronospora												
Pithomyces/Ulocladium												
Rusts												
Smuts/Myxomycetes												
Stachybotrys												
Stemphylium												
Torula												
Unidentified Conidia												
Notes:												

Prepared By:
CS Review:

Technical Review:
Final Review:

AESI
1112 Charleston Ct.
Keller, TX 76248
Attn: Dr. David Anderson

AIHA Empat No. 102297

Air-O-Cell Cassette Analysis

Aerotech Method: A001

Lab Number: A-110-4609
Project Name: 176 Emergency
Project Number: 1082
Date Received: 10/26/01
Date Report Revised: 10/29/01

Lab Number	7			
Sample Identification	Outside, South Side			
Volume (M^3)	0.0750			
Date Analyzed	10/26/2001			
Percent Of Trace Analyzed	100% of Trace at 600X Magnification			
Debris Rating	1			
		Count/M^3		
	Total Count	**Result**	**Detection Limit**	**%**
Mycelial Fragments	<1	<13	13	n/a
Pollen Count	<1	<13	13	n/a
Total Fungal Spores	3	40	13	100
	Fungal Spore Identification			
Alternaria				
Amerospores	3	40	13	100
Arthrinium				
Ascospores				
Aspergillus/Penicillium				
Aureobasidium				
Basidiospores				
Bipolaris/Dreschlera				
Botrytis				
Chaetomium				
Cladosporium				
Curvularia				
Epicoccum				
Fusarium				
Nigrospora				
Oidium/Peronospora				
Pithomyces/Ulocladium				
Rusts				
Smuts/Myxomycetes				
Stachybotrys				
Stemphylium				
Torula				
Unidentified Conidia				
Notes:				

Prepared By:
CS Review:

Technical Review:
Final Review: